Designation: ~~F735 – 11~~ F735 – 17

Standard Test Method for Abrasion Resistance of Transparent Plastics and Coatings Using the Oscillating Sand Method[1]

This standard is issued under the fixed designation F735; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. ~~Scope~~ Scope*

1.1 This test method determines the resistance of transparent plastics and transparent coatings utilized in windows or viewing ports, to surface abrasion using oscillating sand.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.2.1 *Exception*—The inch-pound units in parentheses are provided for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
D618 Practice for Conditioning Plastics for Testing
D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Summary of Test Method

3.1 The test method consists of measuring and recording the haze and light transmission of a test specimen, mounting the specimen so that it forms part of the bottom tray (sand cradle), covering the specimen with abrading media, and subjecting the cradle to a specific number of oscillations. After exposure to the abrasion, the haze and light transmission are remeasured to determine any change in these values.

3.2 At the stroke velocity specified in this ~~practice,~~ test method, the entire mass of sand shifts significantly within the sand cradle because of its inertia; therefore the relative motion between sand and specimen at the interface is large.

3.3 The thickness or height of the sand resting on top of the test specimen remains relatively constant during the motion of the cradle. Therefore, the average pressure of the sand also remains constant, giving highly reproducible results over the entire surface of the test specimen.

3.4 The degree of abrasion is measured by the amount of change in luminous transmission and haze after exposure to the test.

[1] This test method is under the jurisdiction of ASTM Committee F07 on Aerospace and Aircraft and is the direct responsibility of Subcommittee F07.08 on Transparent Enclosures and Materials.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

4. Significance and Use

4.1 Plastic materials, when used as transparencies, covers, or enclosures, are subject to wiping, cleaning, or other types of rubbing actions that cause abrasion. It is the intent of this test method to provide a means of estimating the resistance of such materials to this type and degree of abrasion.

5. Apparatus

5.1 *Abrader*—The abrader consists of a specimen holder, sand cradle, drive mechanism, ~~variable power supply~~ and counter. One such example is shown in Fig. 1.

5.1.1 The specimen holder shall have a cutout approximately 100 by 100 mm (4 by 4 in.) to receive the specimen. Alternative specimen holders can be used to test other ~~coupons~~specimen sizes as long as they can be used within the testing limitations defined in this ~~specification. The specimen shall be mounted flush to within 1 mm (0.04 in.) high with the specimen holder.~~test method.

5.1.2 The specimen holder forms the bottom of the sand cradle.

5.1.3 ~~Sufficient abradent will be used to fill the sand cradle 13-mm (0.50 in.) above the sample surface.~~The sand cradle shall be approximately 250 × 250 × 50 mm (10 × 10 × 2 in.), with the sides set at an angle of 60°.

5.1.4 A drive mechanism shall provide 300 strokes per minute of reciprocating motion of approximately 100-mm (4-in.) travel. Motion in one direction is defined as one stroke. One forward stroke and one reverse stroke ~~is~~are defined as one ~~oscillation.~~oscillation or cycle.

~~5.1.5 A variable power supply shall be utilized to control the abrader motor to operate at 300 strokes per minute.~~

5.1.5 A counter shall record the number of strokes (or cycles) during a test.

5.2 *Photometer*—An integrating sphere photoelectric photometer, described in Test Method D1003, shall be used to measure ~~the light scattered by the abraded surface.~~light transmission (LT) and haze.

6. Reagents and Materials

6.1 *Abrading Medium—Quartz Sand*[3]—The sand shall be quartz silica, graded ~~4/10,~~6/9, and shall meet the following requirements:

~~6.1.1 *Properties*—See Table 1.~~

6.1.1 ~~*Test Methods:*~~ *Properties (typical)*—

~~NOTE 1—These tests need be applied only when qualifying a new supply of sand.~~See Table 1 for sieve analysis percent retained.

NOTE 1—The use of quartz silica sand 6/12 or 4/10 specified in previous versions of this test method can still be used if available. See Appendix X1 for additional details

~~6.1.2.1 Perform sieve analysis in accordance with Test Method C136.~~

~~6.1.2.2 Plot the cumulative percent retained, on logarithmic probability paper.~~

~~6.1.2.3 Read from the plot the sizes in millimetres at 40, 50, and 90 % retained.~~

~~6.1.2.4 Calculate the uniformity coefficient as the ratio (millimetres at 40 %/millimetres at 90 %).~~

~~6.1.2.5 Count out 100 grains, taking care to be nonselective, and weigh to ± 10 mg.~~

[3] The sole source of supply of the sand known to the committee at this time is ~~Oglebay Norton Industrial Sands,~~ Premier Silica LLC, Brady, TX 76825. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

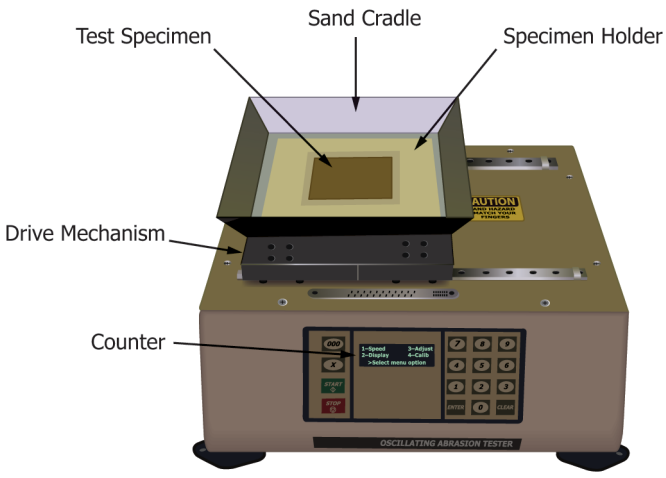

FIG. 1 Oscillating Sand Abrader

TABLE 1 Properties

E11 Sieve Designation		~~Mean~~ % ~~on~~ ~~Sieve~~	~~Standard Deviation, %~~	~~Cululative % Retained, Mean~~
U.S. ~~No~~	mm			
~~4~~	~~4.75~~	~~0~~		~~0~~
~~6~~	~~3.35~~	~~7.6~~		~~7.6~~
~~7~~	~~2.8~~	~~22.3~~		~~29.9~~
~~8~~	~~2.36~~	~~45.1~~		~~75.0~~
~~10~~	~~2.00~~	~~21.9~~		~~96.9~~
~~12~~	~~1.70~~	~~2.6~~		~~99.5~~
~~Pan~~	~~...~~	~~0.5~~		~~100.0~~

TABLE 1 Properties

E11 Sieve Designation		Individual % Weight Retained
U.S. No.	mm	
5	4.00	0 – 7
6	3.36	2 – 11
7	2.83	15 – 25
8	2.38	30 – 50
10	2.00	20 – 40
12	1.68	1 – 7
Pan	...	< 1 – 5

[A] Physical Analysis: Roundness 0.6+; Sphericity 0.6+; Hardness 7.0; S.G. 2.65, Loss on Ignition 0.1; MP 2800°/3100°; Color Tan/White; pH ~~6.9-7.0.~~ Neutral ~~Typical~~ 7.0.
Chemical Content (%); SiO_2 99.48; Fe_2O_3 0.06; Al_2O_3 0.21; MgO < 0.01; CaO < ~~0.01;~~ < 0.01; and TiO_2 < 0.01.

~~6.1.2.6 Calculate the shape factor as~~

$$\frac{\text{(weight of 100 particles)}}{265\ \text{(millimetres at 50 \% retained)}^{3}} \quad (1)$$

~~NOTE 2—There are many conflicting definitions of shape factor.[4] The definition given in 6.1.2.6 is arbitrary and not comparable with any others, except that for a single quartz sphere it has the usual value of 0.524 (π/6).~~

7. Test Specimens

7.1 The specimens shall be clean, transparent plates, 100-mm (4-in.) square, having both sides substantially plane and parallel, unless otherwise specified and defined in 5.1.1. Three specimens shall be tested. Any specimen thickness can be utilized ~~when positioned in the specimen holder to conform to~~provided the specimen is flush with the specimen holder when mounted (see 9.2~~the~~).

NOTE 2—A protective backing material may be applied to the unabraded side of the specimen to prevent scratching during testing and handling. Prior to measuring light transmission and haze, remove the backing material and clean the specimen thoroughly according to 9.4.1.~~mounting tolerances.~~

8. Conditioning

8.1 Where conditioning of the test specimen is required, utilize Procedure A of Practice D618.

8.2 Tests shall be conducted in the Standard Laboratory Atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity, unless otherwise specified.

9. Procedure

9.1 ~~Calibrate motor speed to 300 strokes per minute with the specimen~~ Prior to testing, clean the specimen using the procedure described in 9.4.1~~the specimen holder plate and the desired quantity of sand in the cradle.~~. Measure the specimen's initial average transmission and haze in accordance with 9.5~~Sand used for calibration shall be discarded.~~.

~~9.2 Prior to testing, measure the specimens transmission and haze in accordance with 9.7.~~

9.2 Mount ~~a~~the specimen in the ~~holding plate~~specimen holder using a protective means (such as ~~masking) to prevent abrasion or scratching of~~ masking tape) to secure in place and prevent sand from damaging the specimen's bottom surface. The specimen shall be mounted flush to within ±1 mm (0.04 in.) of the specimen holder.

9.3 ~~Cover~~ Fill the sand cradle and cover specimen with sand to a uniform depth of 13 mm (0.50 in.).

NOTE 3—For a sand cradle 10 in. × 10 in., 800 mL of sand has been found to be sufficient to obtain a uniform depth of 13 mm (0.50 in.).

9.3.1 A given batch of sand may be used for a maximum of 600 ~~strokes.~~ strokes (300 cycles). New sand shall be used for each specimen tested.

~~9.5 Subject the specimen to 100, 200, 300, and 600 strokes.~~